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**Development, regeneration, and evolution of feathers.**

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**Public Summary:**

The feather is a complex ectodermal organ with complex branching patterns. Depending on their configuration, feathers can maintain body temperature, be used for communication, or play an essential role for flight. Studies of feather growth, cycling, and health are very important to understand many aspects of birds. Feathers are an excellent model in which study cellular and molecular aspects of how organs are shaped. Here we review progress that has been made on the development, regeneration, and evolution of organ systems using the feather model over the past three decades. We cover the development of feather buds in chicken embryos, regenerative cycling of feather follicle stem cells, formation of branching patterns and pigmentation patterns, how hormones regulate feather growth, the identification of genes that form several feather variants and the evolution of feathers beginning with feathered dinosaurs. Since the feather is made of very strong yet light weight material, it has served as an inspiration to scientists studying biomaterials and how to increase the efficiency of airplanes in flight; hence feathers have become a multidisciplinary research focal point.

**Scientific Abstract:**

The feather is a complex ectodermal organ with hierarchical branching patterns. It provides functions in endothermy, communication, and flight. Studies of feather growth, cycling, and health are of fundamental importance to avian biology and poultry science. In addition, feathers are an excellent model for morphogenesis studies because of their accessibility, and their distinct patterns can be used to assay the roles of specific molecular pathways. Here we review the progress in aspects of development, regeneration, and evolution during the past three decades. We cover the development of feather buds in chicken embryos, regenerative cycling of feather follicle stem cells, formation of barb branching patterns, emergence of intrafeather pigmentation patterns, interplay of hormones and feather growth, and the genetic identification of several feather variants. The discovery of feathered dinosaurs redefines the relationship between feathers and birds. Inspiration from biomaterials and flight research further fuels biomimetic potential of feathers as a multidisciplinary research focal point.

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